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ABSTRACT

This publication contains two topics concerning estimation and problem solving contained in one volume. It illustrates to parents that there are many opportunities every day to develop, nurture, and refine their child's mathematics skills. The section on estimation is rich with ideas on how to help a child become a better estimator using everyday situations. The problem solving section is filled with real-world problem solving situations that require a solving strategy and reviews the solutions. (ASK)

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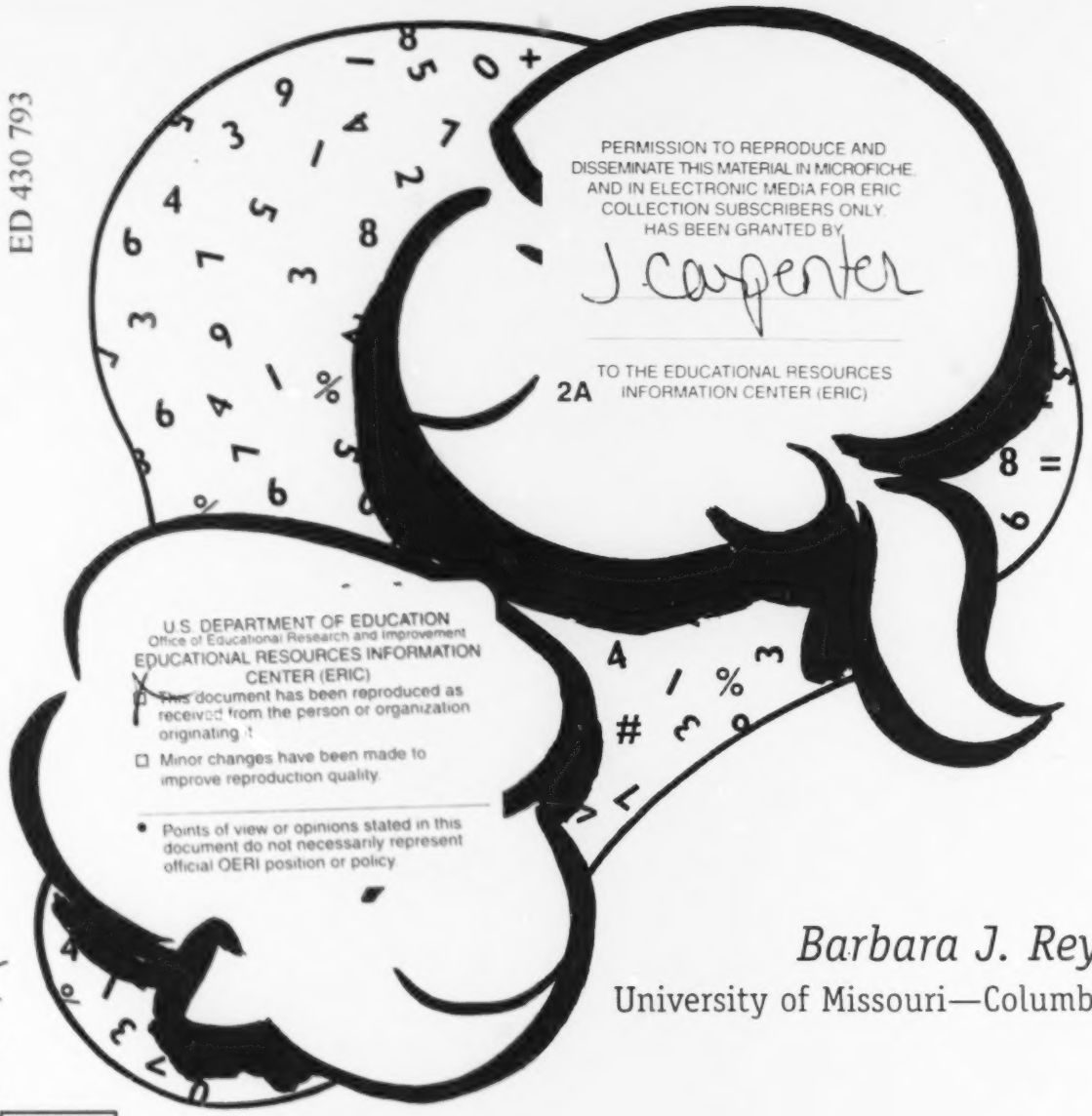
Elementary School Mathematics: What Parents Should Know about ...

Problem Solving

ED 430 793



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National Council of Teachers of Mathematics

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Second Edition

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PROBLEM SOLVING

Learning begins the moment a child is born, long before formal schooling begins. This learning process continues in the home, beyond the school day, with "real world" experiences and interactions with parents, siblings, other children, and adults. The influence a parent has on the beginning educational development of a child is unquestionable and profound; a parent's attitude and interest will greatly influence a child's attitude toward, and interest in, learning.

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As a parent, you have many opportunities every day to develop, nurture, and refine your child's mathematics skills. This pamphlet is designed to help you become aware of these opportunities and to encourage you to participate in your own child's learning process.

WHAT IS PROBLEM SOLVING?

Your child spends from thirty-five to sixty minutes a day studying mathematics in school. The particular topic may be fractions, graphing, measurement, computation, geometry, or other important mathematics-related topics. The most important goal in all these topics is to help your child learn to solve problems. No matter how well children can perform arithmetic calculations or accurately measure a line, unless they know when and how to apply these skills, they will not be fully prepared for the society in which we live. As adults, we know we face situations involving mathematical problems almost every day:

- Deciding if we have enough money to purchase a list of items at the store
- Reading a map to find out where we are
- Building a budget (at home or work)
- Deciding on the shortest route to the stadium
- Developing a weekly schedule for family activities

These situations are examples of real-world problem solving. They require: *identifying a strategy* to solve the problem (e.g., identifying one or more strategies for solving the problem then choosing an efficient strategy); *choosing appropriate tools* (e.g., is a spreadsheet or calculator helpful in organizing or calculating data?); *applying the strategy* (e.g., collecting additional information or doing one or more calculations);

and *reviewing the solution* (e.g., does it make sense?). Problem solving is the process of applying what we already know to new and unfamiliar situations.

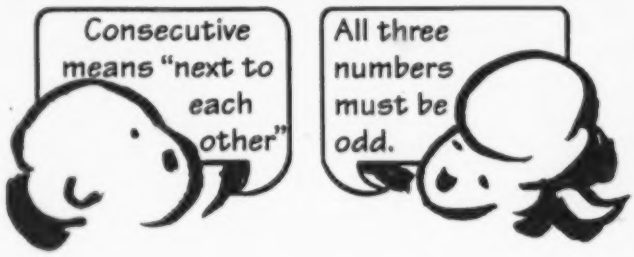
In school, teachers attempt to develop problem-solving skills by giving students problems that require them to think through both the problem and the solution. For example:*

> Find three consecutive odd numbers whose sum is 153.

* Many of the problems presented in this brochure are from *Techniques of Problem Solving* published by Dale Seymour. See the suggested materials for more information.

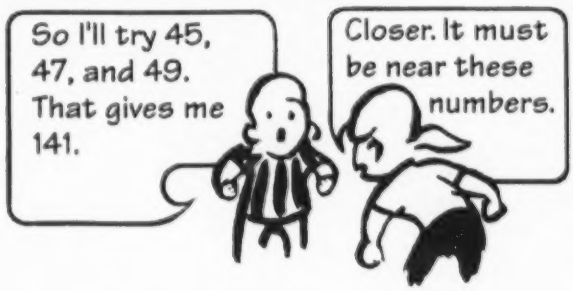
The solution to this problem is not immediately obvious. The child must first understand the problem (What does consecutive mean? What is a sum?) before making decisions on how to find the solution. Characteristics of good problem solvers include these four:

- The ability to identify important details

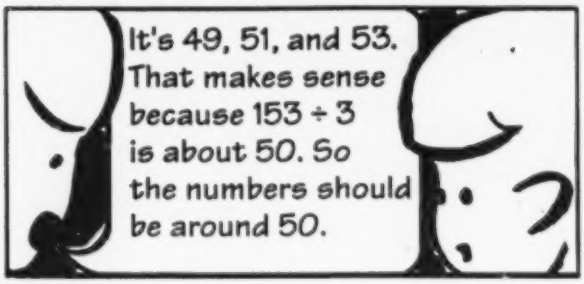


- Flexibility of thinking

- Perserverance



- A sense of knowing what is reasonable



HOW CAN PARENTS HELP?

Here are some general guidelines to help you help your child develop problem-solving ability:

- *Emphasize the importance of problem solving* as well as the enjoyment and self-satisfaction that can be derived from it.
- *Take advantage of your child's curiosity* about numbers and shapes in our world by asking and responding to questions.
- *Help your child become aware of the thinking* he or she uses in problem solving.
- *Help your child,* through questions and shared experiences, *to develop effective strategies* for attacking a problem.
- *Spend time with your child* on a regular basis working on solving a variety of problems.

SAMPLE ACTIVITIES AND PROBLEMS

There are many books that provide good sets of problems to work through with your child. (See the reference list at the end of this brochure.) Here are a few problems to get you started.

- Use the experiences and materials around you and your child every day to pose questions and involve your child in problem solving.
- A variety of learning experiences can be developed using your daily newspaper:

  Cut out each frame of a comic strip, mix them up, and ask your child to put them back into correct sequence.

  Select an article from a page in the newspaper. Ask your child to predict which vowel or consonant will appear most frequently. Let the child count and organize the information, then discuss the results.

  Find and study the statistics reported on the sports page. Describe some of the numbers used and what they represent. How do they change from day to day?

  How is the index of the paper used? Can your child locate certain features of the paper using it?

  Circle the numbers presented on one page in the newspaper. What is the largest number? The smallest? Are there more whole numbers, fractions, or decimals? Decide what kind of numbers are used most often—estimates or exact values.

  Use the information presented in a sale ad to find how much is saved from the regular price.

- Children should be encouraged to use objects they can touch or watch, as well as words, in their problem-solving activities. Young children are especially limited in their use of words, but they can solve a

variety of problems with their hands and eyes. (Answers are at the end.)

1. With one quarter, two dimes, five nickels, and twenty-five pennies, how many different ways can you make 25¢?
2. Fold a sheet of paper in half. How many parts is the paper divided into? Fold it again. How many parts are there now? What is each part called? Fold it again. How many parts are there now? What is each part called? Can you predict how many pieces there will be if the paper is folded again?
3. Cut out newspaper ads for five different items. Arrange them according to price, from greatest to least. What two items can you buy for $10? Can you buy three different items for $8? If you had $20 and bought the cheapest item, how much change would you get back?

- Children need to solve a *variety* of problems, especially problems that can be solved in more than one way.

4. How many tiles were needed to cover our bathroom floor? Is there a way to find out without counting each tile? Describe it.
5. This is a "34" magic square. How many ways can you find 34?

7	12	1	14
2	13	8	11
16	3	10	5
9	6	15	4

- When children use hand-held calculators in problem solving, they are more likely to use the thinking strategies that are necessary for good problem solving. Children are very motivated by calculators and may persevere longer when using them.

6. Jane spent $30.84. Which three items did she buy?

7. A stereo advertised for $399.95 can be purchased for $100 down and $39.95 a month for 12 months. How much does the stereo cost when purchased on this installment plan?
8. Use only the digits 1, 2, 3, and 4 (once each) to form a multiplication problem of this form:

____ ____

× ____ ____

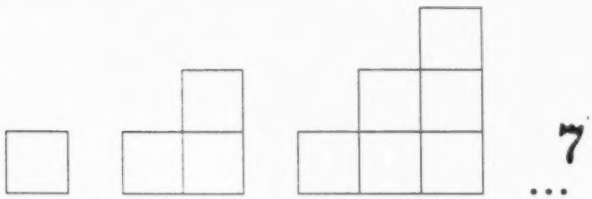
What arrangement makes the largest product? Smallest? Use questions that will lead the child to become aware of the importance of the tens digit with regard to the size of the resulting product.

- Help your child become more aware of ways in which the world is mathematical and invites problem solving. A variety of problems become clear by simply taking advantage of problem-solving situations that arise naturally.

  9. If you drink three glasses of milk a day, how much is that a week? If everyone in the family drinks that much milk, how much will be needed for the whole week?
  10. Suppose a soft-drink machine takes quarters, dimes, and nickels and accepts exact change only. If a can costs 75¢, how many ways are there to purchase a can?
  11. Guess how many books are on the top bookshelf. Count them. Now, guess the number of books in the entire bookcase.
  12. Look at the license plate numbers while riding in a car. Find one that is divisible by 2. Find one that is divisible by 5. Find one that is divisible by 2 and 5.

- Help your child to recognize both number and shape patterns. Children love patterns. You can make games out of them.

  13. Can you draw the next piece in this picture? How many squares will it contain?



  14. Find the pattern and then use it to find the missing number: 1, 3, 7, 13, 21, ___, ___.
  15. Write the phone numbers of three of your friends. Compare them. Find three ways they are alike. Find three ways they are different.

- Use your child's interest in puzzles and games to help develop the sorting and organizing skills that good problem solvers use.

  16. Get a deck of cards. Remove the face cards. Deal four cards to yourself and one in the middle. Try to make equations with some or all of your cards equal to the value of the card in the middle.
  17. What is your name worth if A = 1 point, B = 2 points, C = 3 points, ... Z = 26 points? Can you find a name or word worth exactly 100 points?

The earlier children begin to solve problems, the better. Young children are natural problem solvers, with natural inclinations to organize information, to ask questions and seek answers, to recognize patterns, and to be curious about the numbers and shapes that help define the world around them.

Instruction in problem solving is most effective (1) when children sense that you regard problem solving as an important skill and that you actively engage in solving problems yourself, and (2) when you share these experiences with the child.

The specific mathematics exercises you do with your child are probably not as important as the influence of your interest and attitude. We encourage you to continue to help your child learn, both at school and at home. You are your child's most important learning resource.

Many sample problems and activities have already been suggested in this brochure. In the middle of this brochure is a problem-solving poster that you can

attach to the refrigerator or a convenient, visible location and begin to work through with your child. You may wish to record solutions and the date they are found. This poster is only a start. Use your own varied experiences and your imagination to supplement and extend these ideas.

SUGGESTED MATERIALS

Many excellent materials are available to help you guide your child in developing problem-solving ability. Your child's mathematics textbook is one source. The textbook publisher may also have supplementary materials available on problem solving. Check with your child's teacher. Additional sources of good materials are listed here.

Greenes, Carole, George Immerzeel, Earl Ockenga, Linda Schulman, and Rika Spungin. *Techniques of Problem Solving*. Dale Seymour Publications, P. O. Box 10888, Palo Alto, CA 94303. 1980.

A deck of problem-solving cards (one problem per card) is included in each of four boxes.

Stenmark, Jean Kerr, Virginia Thompson, and Ruth Cossey. *Family Math*. Dale Seymour Publications. P. O. Box 10888, Palo Alto, CA 94303.

Currie, Stephen. *Problem Play* (Grades 1–3). Dale Seymour Publications. P. O. Box 10888, Palo Alto, CA 94303.

Seymour, Dale. *Problem Parade* (Grades 4–6). Dale Seymour Publications. P. O. Box 10888, Palo Alto, CA 94303.

ANSWERS

1. 13 ways:

25 pennies		
20 pennies,		1 nickel
15 pennies,	1 dime	
15 pennies,		2 nickels
10 pennies,	1 dime,	1 nickel
10 pennies,		3 nickels
5 pennies,	2 dimes	
5 pennies,	1 dime,	2 nickels
5 pennies,		4 nickels
	2 dimes,	1 nickels
	1 dime,	3 nickels
		5 nickels
		1 quarter

2. Answers will vary depending on how paper is folded.
3. Answers will vary.
4. Answers will vary.
5. 10 ways (by adding each column, row, and diagonal) and 10 ways (by adding four numbers in a patterned manner, such as the four corners or the two inside squares from the top row and the two inside squares from the bottom row)
6. 14.99 + 14.86 + .99
7. $179.45
8. Largest: $\begin{array}{r} 41 \\ \times\ 32 \\ \hline 1312 \end{array}$ Smallest: $\begin{array}{r} 13 \\ \times\ 24 \\ \hline 312 \end{array}$
9. 21 glasses; answers will vary
10. 8 ways:

1 quarter,	2 dimes	
1 quarter,	1 dime,	2 nickels
1 quarter,		4 nickels
	4 dimes,	1 nickel
	3 dimes,	3 nickels
	2 dimes,	5 nickels
	1 dime,	7 nickels
		9 nickels

11. Answers will vary.
12. Answers will vary.
13. 10 squares
14. 1, (+2) 3, (+4) 7, (+6) 13, (+8) 21, (+10) *31*, (+12) *43*
15. Answers will vary.
16. Answers will vary.
17. Answers will vary.

ANSWERS TO PROBLEM-SOLVING POSTER

Starting at bottom:

1. Answers will vary.
2. DF; FH
3. 21
4. 34
5. 42 − 4 + 1 − 24 = 15
6. right angle (3:00, 9:00)
   acute angle (answers will vary, for example 3:10 or 3:05)
   obtuse angle (answers will vary, for example 4:00 or 6:05)
7. Answers will vary.
8. Answers will vary.
9. 111 131 151 171 191
   113 133 153 173 193 — 25 between 100 and 200
   115 135 155 177 195
   117 137 157 177 197
   119 139 159 179 199
   311 331 351 ...
   313 — 25 between 300 and 400
   •
   •
   •
   511 ...
   • — 25 between 500 and 600
   •
   •
   711 ...
   • — 25 between 700 and 800
   •
   •
   911 ...
   • — 25 between 900 and 1000
   •
   •

   $5 \times 25 = 125$
10. Joe is 9; his sister is 3

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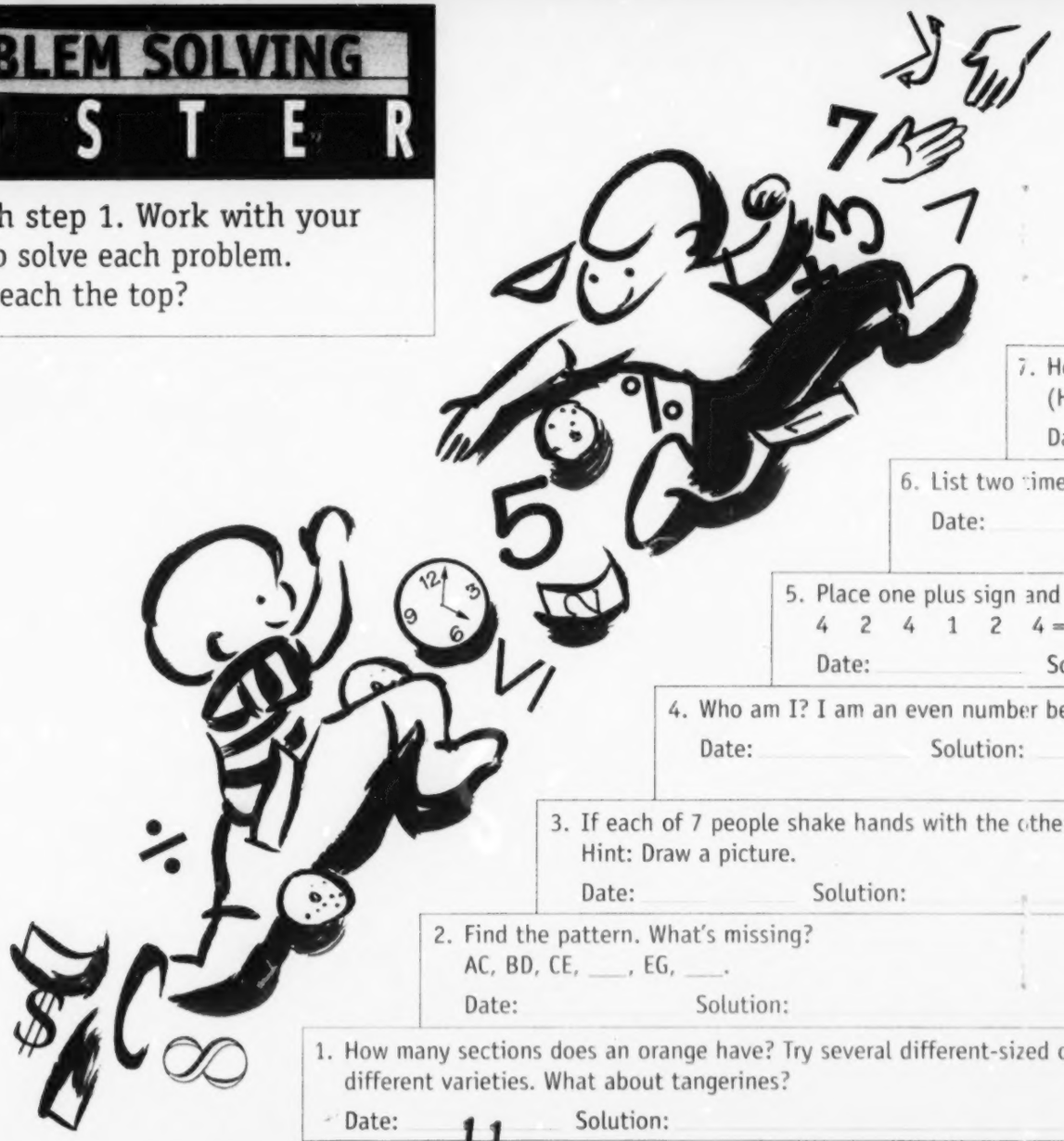
PROBLEM SOLVING POSTER

Start with step 1. Work with your parents to solve each problem. Can you reach the top?



10. Joe says he is now three times as old as his sister. Last year he was four times as old. How old are Joe and his sister? Guess; then check your guess.

    Date: Solution:

9. Find a 3-digit number that has all odd digits. How many such numbers are there? List them.

    Date: Solution:

8. Can you spend a million dollars? You can't give away money and you can't buy more than two of the same item. (Use catalogs and a calculator.)

    Date: Solution:

7. How many years old are you? How many months old are you? How many days old are you? (How did you handle leap years?)

    Date: Solution:

6. List two times when the hands of a clock form a right angle; an acute angle; an obtuse angle.

    Date: Solution:

5. Place one plus sign and two minus signs between these numbers to make the left side equal 15.

    4 2 4 1 2 4 = 15

    Date: Solution:

4. Who am I? I am an even number between 20 and 40. When you add my digits, the sum is 7.

    Date: Solution:

3. If each of 7 people shake hands with the other 6 people, how many handshakes will there be? Hint: Draw a picture.

    Date: Solution:

2. Find the pattern. What's missing?

    AC, BD, CE, ___, EG, ___.

    Date: Solution:

1. How many sections does an orange have? Try several different-sized oranges and different varieties. What about tangerines?

    Date: Solution:

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NCTM STATEMENT OF BELIEFS

As the primary professional organization for teachers of mathematics in grades K–12, the National Council of Teachers of Mathematics (NCTM) has the responsibility to provide broad national leadership in matters related to mathematics education.

In meeting this responsibility, NCTM has developed a set of standards for school mathematics that address content, teaching, and assessment. These standards are guidelines for teachers, schools, districts, states, and provinces to use in planning, implementing, and evaluating high-quality mathematics programs for kindergarten through grade 12.

The NCTM *Standards* are based on a set of core beliefs about students, teaching, learning, and mathematics.

We believe the following:

- Every student deserves an excellent program of instruction in mathematics that challenges each student to achieve at the high level required for productive citizenship and employment.
- Every student must be taught by qualified teachers who have a sound knowledge of mathematics and how children learn mathematics and who also hold high expectations for themselves and their students.
- Each school district must develop a complete and coherent mathematics curriculum that focuses, at every grade level, on the development of numerical, algebraic, geometric, and statistical concepts and skills that enable all students to formulate, analyze, and solve problems proficiently. Teachers at every grade level should understand how the mathematics they teach fits into the development of these strands.
- Computational skills and number concepts are essential components of the mathematics curriculum, and a knowledge of estimation and mental computation is more important than ever. By the end of the middle grades, students should have a solid foundation in number, algebra, geometry, measurement, and statistics.
- Teachers guide the learning process in their classrooms and manage the classroom environment through a variety of instructional approaches directly tied to the mathematics content and to students' needs.
- Learning mathematics is maximized when teachers focus on mathematical thinking and reasoning. Progressively more formal reasoning and mathematical proof should be integrated into the mathematics program as a student continues in school.
- Learning mathematics is enhanced when content is placed in context and is connected to other subject areas and when students are given multiple opportunities to apply mathematics in meaningful ways as part of the learning process.
- The widespread impact of technology on nearly every aspect of our lives requires changes in the content and nature of school mathematics programs. In keeping with these changes, students should be able to use calculators and computers to investigate mathematical concepts and increase their mathematical understanding.
- Students use diverse strategies and different algorithms to solve problems, and teachers must recognize and take advantage of these alternative approaches to help students develop a better understanding of mathematics.
- The assessment of mathematical understanding must be aligned with the content taught and must incorporate multiple sources of information, including standardized tests, quizzes, observations, performance tasks, and mathematical investigations.
- The improvement of mathematics teaching and learning should be guided by ongoing research and by ongoing assessment of school mathematics programs.

Changing mathematics programs in ways that reflect these beliefs requires collaborative efforts and ongoing discussions among all the stakeholders in the process. NCTM stands ready to work with all those who care about improving mathematics education for all students. Through such dialogue and cooperative efforts, we can improve the mathematical competence of the students in mathematics classes across the continent.

Elementary School Mathematics: What Parents Should Know about ...

Estimation

Barbara J. Reys
University of Missouri—Columbia

Second Edition

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ESTIMATION

Learning begins the moment a child is born, long before formal schooling begins. This learning process continues in the home, beyond the school day, with "real world" experiences and interactions with parents, siblings, other children, and adults. The influence a parent has on the educational development of a child is unquestionable and profound; a parent's attitude and interest will greatly influence a child's attitude toward, and interest in, learning.

As a parent, you have many opportunities every day to develop, nurture, and refine your child's mathematics skills. This pamphlet is designed to help you become aware of these opportunities and to encourage you to participate in your own child's learning process.

WHAT IS ESTIMATION?

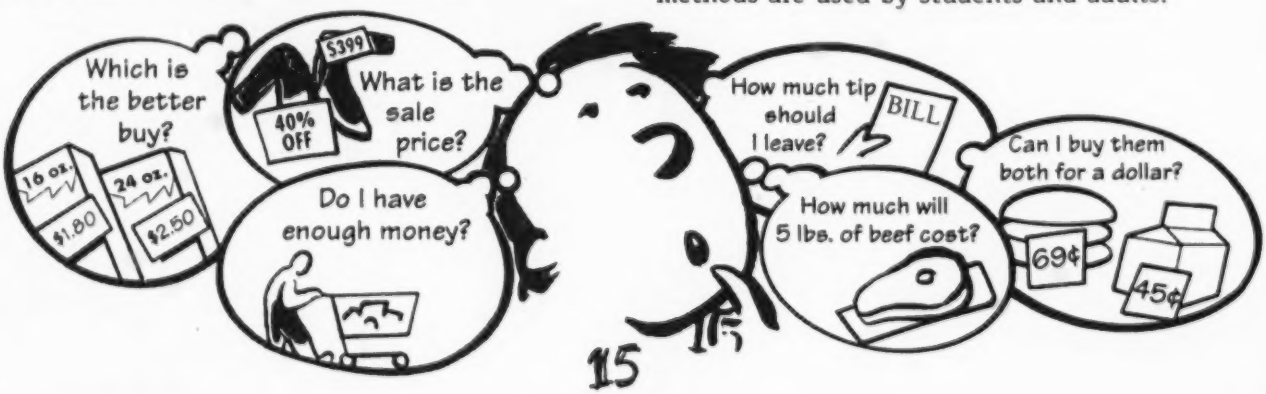
Estimation is the process of making a reasonably accurate guess to a computation or measurement situation. It is a basic skill we all use every day. As adults, we are involved in many situations where it is not convenient or necessary to use paper and pencil or a calculator to find an exact total. For these situations, we have learned to estimate. How many of the situations below have you encountered during the past week?

You probably would use estimation in each of these instances. Estimation is prominently involved in cooking, traveling, buying, repairing, business transactions—almost all our life skills. As adults, we may use estimation as much as 80 percent of the time rather than calculating exact answers.

HOW YOU CAN HELP YOUR CHILD DEVELOP ESTIMATING SKILLS

Although estimation is taught in school, a child can benefit from practice at home. You can help your child develop this important skill by sharing some of your own estimating techniques. For instance, estimating the tip in a restaurant can almost be considered a life skill! How do *you* do it?

For estimating a 15 percent tip, do you take 10 percent of the bill and then add half of that, or do you convert 15 percent to an approximately equivalent fraction (1/6 or 1/7) and use this to calculate the estimate? Do you take 10 percent of the bill and add some, or do you take 20 percent of the bill and subtract some? Do you multiply mentally a rounded form of the total by 0.15? A study has found that all these methods are used by students and adults.



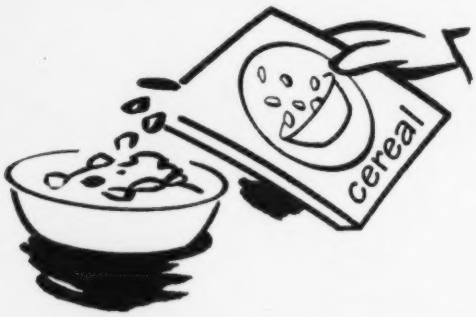
There are many ways to estimate—you have probably found a way that is comfortable and useful for you. Discussing various estimation techniques as situations arise may help you child learn them and also develop new strategies.

CHILDREN AND ESTIMATION

Studies report the following findings about children and estimation:

- Without instruction, children generally do poorly when asked to estimate.
- Children need to be reminded of how useful estimating is in everyday life.
- Instruction must involve meaningful situations where students formulate estimates based on their own knowledge and the problem context.
- Children enjoy estimating when they recognize its importance and have begun to learn some estimating techniques.

Much of your child's time in the mathematics classroom is spent learning to solve problems involving exact answers. Although this is important, it needs to be complemented with instruction in estimating. This is where you as a parent can help. It takes time and experience for a child to understand when an exact answer is needed and when an estimate is needed. Talk to your child about situations where you estimate. Share your thinking. Don't wait until children have mastered computation to start ... learning estimation techniques takes time. Before children count, they can estimate how much cereal will fit in a bowl, how much sand in a pail,



how far to jump to clear an obstacle, how many crayons will fit in a box. As children grow older, you can help them to notice the many approximate numbers in the world. For instance, newspapers and magazines use both exact numbers and estimates. Ask your child to think about why estimates are given in some of these situations:

McDonald's Billions and Billions Served
TEAM BATTING AVERAGE .300
Scout Troop 451 Fund Drive Goal $600
school play 7:30 pm
school enrollment over 400
HEADLINE 2,500 Killed In Massive Quake
We're traveling at an altitude of 40,000 feet

HOW EXERCISES IN MENTAL ARITHMETIC CAN HELP

As children begin doing basic computations involving addition, subtraction, multiplication, and division, they should also be given experiences in mentally computing certain types of problems (e.g., 30 + 40 or 7 × 60). Efficient estimating requires an ability to solve these kinds of problems mentally. If children are encouraged to do mental computation, and gain agility and confidence in their skill, they will find all kinds of estimation easier. Help your child practice mental computation at home by doing short drills regularly. Let children keep a chart of their progress—they will note their improvement themselves.

For young children: What is 1 more that 46? 3 more than 40? 10 less than 86? 20 plus 30?

For older children: What is 400 + 800? 500 + 117? 30 × 7? 100 × 41? 50% of 420? 1/4 of 36? 1/2 + 1/4?

Encourage your child to give you these same types of problems to work in your head. As you work through them and succeed, your child will become more motivated to work on these kinds of problems.

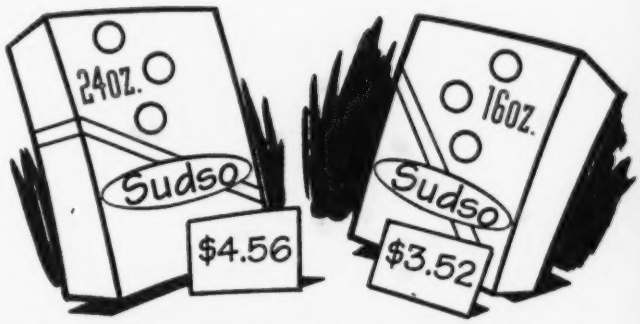
ESTIMATION IDEAS AND EXAMPLES

The best way you can help your child become a better estimator is simply to take advantage of your own estimation experiences and share them. Here are several ideas to get you started—you can think of many more.

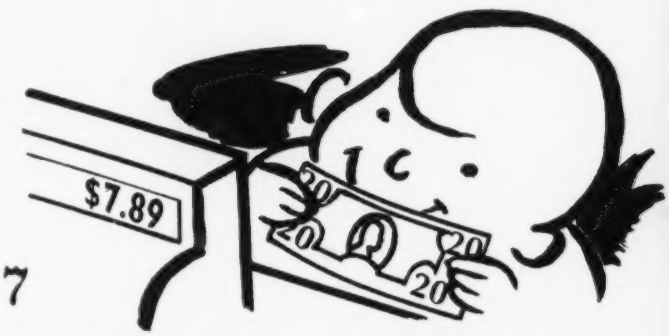
While shopping or browsing through newspaper sale ads, you and your child can ask each other questions and discuss estimation strategies.

Management Trainee
Major national publishing company has an opportunity in sales for career-minded man/woman. Immediate opening. Starting salary $575/week. No expereince necessary. Call 555-1133.

Estimate the yearly salary.

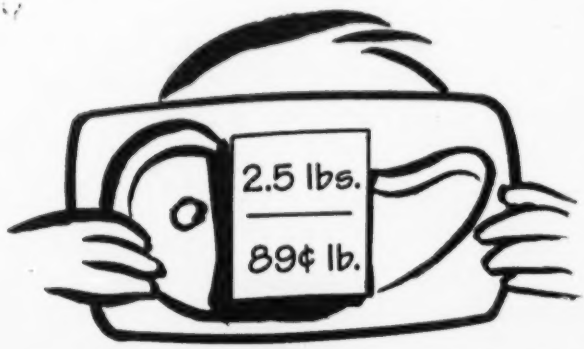


Which package of SUDSO is the better buy?



About how much change will you get?

The bill is $28.75. Estimate the tip if you leave about 15 percent.

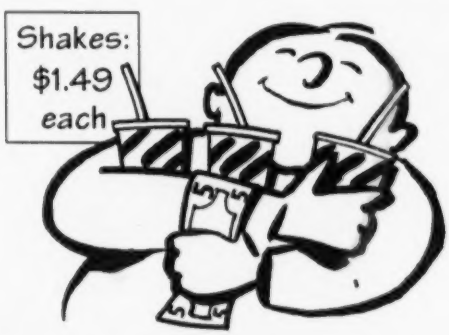


Estimate how much this meat will cost.

Estimate the sale price.

About how much does 1 can cost?
About how much will 9 cans cost?

Estimate the total for the groceries before they are totaled.



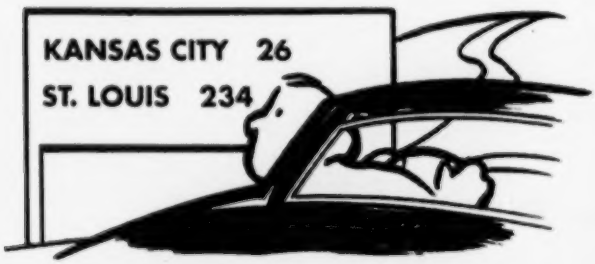
Can you buy 3 shakes with a $5 bill?

If tax is 7.85 percent, estimate the tax on this purchase.

What can you buy with $6.00?
Estimate the price of a hot dog, salad, and two milks.

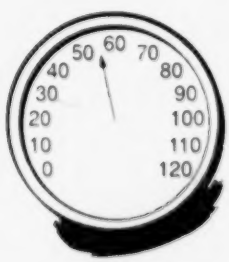
Estimate the total.

A trip in the car also provides many opportunities to estimate—you need only to be alert for them.

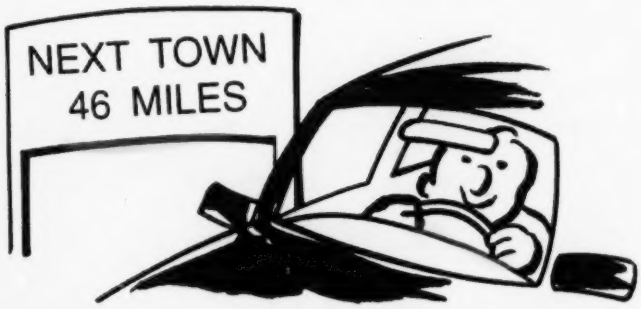


About how far is it between the cities? More than 200 miles? Less than 200 miles?

If it took 19 gallons of gasoline to travel 425 miles, about what is the average miles per gallon?



About how long will it take us to travel 300 miles?



About how long will it take us to get to the next town?

If the game starts at 5:45, about how much time do we have before it starts?

There are many opportunities to estimate measurements around the home. Children love to guess and then measure distance, weight, and capacity.

Use your weight to guess your brother's or sister's weight.

About how many books are on the top shelf of the bookcase? Estimate, then count them. About how many books are in the whole bookcase?

If every person in our family will eat about half a cup of macaroni, how much should be fixed? (If possible, let the child measure the needed macaroni.)

The bank balance was $426.00. Checks for $48.00 and $39.78 were written. Estimate the new balance.

As you engage in estimating with your child, be sure to point out that estimating is a guess based on facts, not just a wild guess. It is important to ask how your child arrived at the estimate to see if there is some legitimate basis for the guess.

HOW YOUR CHILD WILL BENEFIT

Learning to use estimating techniques will have several benefits for your child:

- With the increased use of calculators, estimating skills take on new importance. Estimating makes children more aware of an unreasonable answer displayed on a calculator.
- An awareness of the frequent everyday uses of estimation helps children see and appreciate the practicality of mathematics.
- Skill in estimating will strengthen computational skills by providing children with a reasonable estimate for a final answer.
- Estimation procedures are closely associated with problem-solving techniques; as children become adept at estimating, they will be developing important thinking strategies.
- When they are comfortable with the process, children like to estimate. Your involvement will help them develop a healthy and positive attitude toward the study of mathematics

If you want to help your child develop estimation skills, the best advice is this:

Take advantage of the many situations in which you estimate and share these experiences and your thought processes with your child. Your child will also benefit from discussing the ways he or she estimates. Be open and ready for these discussions—you may pick up a few new estimation techniques yourself!